STATE OF VERMONT
PUBLIC SERVICE BOARD

Docket No. 6860

Petitions of Vermont Electric Power Company, Inc. ("VELCO") and Green Mountain Power Corporation ("GMP") for a Certificate of Public Good authorizing VELCO to construct the so-called Northwest Vermont Reliability Project, said project to include: (1) upgrades at 12 existing VELCO and GMP substations located in Charlotte, Essex, Hartford, New Haven, North Ferrisburg, Poultney, Shelburne, South Burlington, Vergennes, West Rutland, Williamstown, and Williston, Vermont; (2) the construction of a new 345 kV transmission line from West Rutland to New Haven; (3) the construction of a 115 kV transmission line to replace a 34.5 kV and 46 kV transmission line from New Haven to South Burlington; and (4) the reconductoring of a 115 kV transmission line from Williamstown, to Barre, Vermont

PREFILED SURREBUTTAL TESTIMONY OF GEORGE E. SMITH & W. STEVEN LITKOVITZ ON BEHALF OF THE VERMONT DEPARTMENT OF PUBLIC SERVICE

September 3, 2004

Summary: Mr. Smith and Mr. Litkovitz respond to testimony offered in rebuttal by Dr. Fagen concerning various aspects of VELCO's analysis; Scudder Parker concerning the reliability of phase angle regulators and the consistency of the proposed NRP with the 1994 Twenty Year Electric Plan; Jean Vissering concerning undergrounding portions of the proposed 345kV line from West Rutland to New Haven; and Tom Dunn concerning the use of ACSS-TW wire and various aspects of the proposed Granite substation. Mr. Smith and Mr. Litkovitz also address a concern raised by the Board during rebuttal cross examination regarding an outage that occurred in New York City in 1999 and address a change in opinion on the reclosure of 115kV hybrid lines.

Prefiled Surrebuttal Testimony
of
George E. Smith & W. Steven Litkovitz

Identification of Witness and Qualifications, Mr. Smith

Q. Please state your name and position.

A. My name is George E. Smith. I am a professional engineer and consultant to the Vermont Department of Public Service (Department).

Q. Are you the same George E. Smith that previously submitted testimony in this proceeding?

A. Yes, I am.

Identification of Witness and Qualifications, Mr. Litkovitz

Q. Please state your name and position.

A. My name is W. Steven Litkovitz. I am an Electrical Engineer for the Vermont Department of Public Service.

Q. Are you the same W. Steven Litkovitz that previously submitted testimony in this proceeding?

A. Yes, I am.

Summary

Q. What is the purpose of your testimony?

A. In this testimony, we respond to testimony offered in rebuttal by Dr. Fagen concerning various aspects of VELCO's analysis; Scudder Parker concerning the reliability of phase angle regulators (PARs) and the consistency of the proposed NRP with the 1994 Twenty Year Electric Plan; Jean Vissering concerning undergrounding portions of the proposed 345kV line from West Rutland to New Haven; and Tom Dunn concerning the use of ACSS-TW wire and various aspects of the proposed Granite substation. We also address a concern raised by the Board during rebuttal examination regarding an outage that

occurred in New York City in 1999 and address a change in opinion on the reclosure of 115kV hybrid lines.

Responses to Dr. Fagen's Rebuttal Testimony

Q. At Q/A 13 of Dr. Fagen's rebuttal testimony, he states that VELCO's emphasis on a Highgate converter outage, in the context of transmission system planning studies, is "subjective" and chosen to "suit [VELCO's] purposes." Dr. Fagen then states that an appropriate analysis would focus on the most failure-prone element of the bulk power system which, according to Dr. Fagen, is the Vermont Yankee generator (VY). Do you agree with Dr. Fagen on this topic?

A. No. Appropriate planning requires that bulk transmission systems be designed to withstand the loss of the most critical element at peak load periods. Then, after a 30-minute period in which to reposition the system, the transmission system must be designed to withstand the loss of the second most critical element. For the transmission system in northwest Vermont, the most critical elements are the Highgate converter and the PV 20 transmission line since the loss of either of these elements has the largest impact on the system and both are vulnerable to an extended outage. While VELCO routinely studies the effects of losing VY in its planning, a VY contingency stresses the transmission system in northwest Vermont to a far lesser degree than an outage of the Highgate converter.

Q. At Q/A 13 of Dr. Fagen's rebuttal testimony, he criticizes VELCO's classification of the Highgate converter as a generator, stating that "it is obviously a transmission facility." Dr. Fagen further states that this classification "magnifies [Highgate's] role in the analysis and worsens the estimate of reliability." Do you agree these statements?

A. No. First, VELCO's classification of the Highgate converter as a generator is appropriate for system analysis because the electrical characteristics of a converter are much closer to that of a generating unit than a transmission line. Specifically, like a generator, the amount of power that flows through a converter can be chosen, within limits, by the operator, while on a transmission line in an alternating current (AC) network, the amount of power flowing through the line is a function of the network's impedances,

generation, and loads at any given instant. Second, Highgate's significant role in reliability assessments in northwest Vermont is not due to its classification; rather it is due to its location, its ability to supply a substantial portion of the real power required in the area, and its ability to stabilize voltage in the area through its reactive power control capability.

Q. At Q/A 20 of Dr. Fagen's rebuttal testimony, in the context of a discussion concerning the line impedances of a reconductored 115kV line, he states that VELCO's use of per unit designations when calculating line impedances confuses the issue. Do you agree with Dr. Fagen on this point?

A. No. The per unit method allows the computation of power flows on a normalized basis independent of the nominal operating voltage at any point in the network. The per unit method of analysis is commonplace and is described in the power systems analysis texts commonly used in academia and industry.

Q. Also at Q/A 20 of his rebuttal testimony, Dr. Fagen states that VELCO's calculated impedance values are wrong and that "they are wrong by factors of a hundred or so." Is Dr. Fagen correct in this assessment?

A. No. After spot checking several values, we conclude that VELCO has correctly calculated its line impedances. It appears that Dr. Fagen's confusion results from VELCO's use of the per unit designation for impedances rather than an ohmic designation.[1]

Q. At Q/A 20 of his rebuttal testimony, Dr. Fagen states that VELCO's use "of the quantity denoted by B does not follow standard practice." Do you agree with Dr. Fagen on this point?

A. No. In power systems analysis, the use of the designation B to denote susceptance is both common and correct. Susceptance, which is the reciprocal of reactance, is used to quantify the shunt elements of transmission lines, such as capacitance.

---

[1] Using per unit methodology for 115 kV on a 100 MVA base, a 1.0 per unit impedance is equal to 132.25 ohms. This ratio of 132.25 to 1 may explain Dr. Fagen's belief that VELCO's calculated impedances "are wrong by factors of a hundred or so."

Responses to Mr. Parker's Rebuttal Testimony

Q. In his rebuttal testimony at page 34, Mr. Parker states that VELCO witness Mr. Montalvo "cites no evidence to suggest that the future performance of PARs, for instance, will be more reliable than the three outages in three years cited by Mr. Dworkin" of the Plattsburgh phase angle regulator. Do you believe that the PARs proposed as part of the NRP will be more reliable than the Plattsburgh PAR has been over the past several years?

A. Yes. The Plattsburgh PAR provided 30 years of reliable service before its first failure in March 2000. For planning purposes, PARs, like other large transformers, are assumed to have service lives on the order of 30 to 40 years. It is reasonable to assume that the new PARs proposed for the NRP would also provide reliable service over the next 30 to 40 years.

Q. In his rebuttal testimony at page 39, Mr. Parker states that the NRP "is not consistent with the 1994 Twenty Year Electric Plan." Does Mr. Litkovitz agree with Mr. Parker's statement?

A. Mr. Litkovitz examined the NRP with respect to the relevant engineering and transmission requirements of the 1994 Twenty Year Electric Plan and with respect to these provisions disagrees with Mr. Parker's statement. This is detailed in a memorandum written by Steve Litkovitz to Hans Mertens dated July 1, 2004, and attached hereto as Exhibit DPS-GES&WSL-2.

Responses to Ms. Vissering's Rebuttal Testimony

Q. In the rebuttal testimony of Ms. Vissering on behalf of the ACRPC, at Q/A 12, she recommends that the Public Service Board consider undergrounding the proposed West Rutland to New Haven 345 kV line in several locations. In regard to this recommendation, Department witness Jay Williams provides cost estimates based on conceptual designs for underground 345 kV segments rated at 500 MVA and 1500 MVA. Why has the Department provided estimates for conceptual designs using these two load levels?

A. An underground system rated for 500 MVA would likely have sufficient thermal

capability to provide transmission service to northwest Vermont under the most severe contingencies. 1500 MVA is a level that matches the thermal capability of the overhead 345 kV line thereby preventing an underground section from becoming the limiting element of the circuit. These levels were chosen as starting points for conceptual designs. The ultimate choice for the thermal capability of underground sections would require further analysis.

Q. In the rebuttal testimony of Ms. Vissering on behalf of the ACRPC, at Q/A 12, she recommends that the Public Service Board consider undergrounding the proposed West Rutland to New Haven 345 kV line in several locations. From the perspective of system reliability, would undergrounding this line in several locations result in a system that is as reliable as a system that results from a line comprised of all-overhead construction?

A. No. As discussed in the surrebuttal testimony of Department witness Jay Williams, reclosing would not be permitted on the 345kV hybrid line - a line containing both overhead and underground sections. This contrasts to an all-overhead design in which reclosing is permitted. As discussed in our reroute testimony, where reclosing is not permitted, faults that otherwise would result in outages of just a few seconds would now result in the loss of a line for several hours so that VELCO operators could determine whether the fault originated in the overhead or underground sections of the line. This change in reliability to the most important element of the NRP, together with the electrical characteristics of underground cable, would result in the need for further system studies and likely would result in the need for VELCO to reapply to NEPOOL for Section 18.4 approval.[2] Further studies and a re-application for Section 18.4 approval would likely result in the delay of construction of the 345kV line and could result in the need for additional elements to the NRP to satisfy reliability criteria.

This discussion of reliability assumes, at a minimum, that the 345kV underground designs provided in the testimony of Department witness Jay Williams in terms of cable

[2]Section 18.4 of the Restated NEPOOL Agreement requires that a proposed addition or modification to the interconnected transmission system have no adverse impact on its operation.

type, size, configuration, and redundancy would be followed. Changes to this design, for example, the use of three cables rather than four for the 500 MVA design, could result in further significant and unacceptable degradation to system reliability.

Responses to Mr. Dunn's Rebuttal Testimony

Q. Beginning at page 10 of his rebuttal testimony, Mr. Dunn provides the results of VELCO's inquiry into the use of ACSS-TW wire. Do you agree with VELCO's conclusions on the use of ACSS-TW wire?

A. Yes. Our original focus on the use of ACSS-TW was based on its superior sag versus temperature (thermal loading) performance over ACSR. VELCO correctly identified that the limiting factor in the Vermont environment is ice loading, not thermal loading. Under heavy ice loading conditions, ACSS-TW offers no advantage over ACSR.

Q. Regarding the configuration of the Granite substation, on page 14 at lines 10 and 11 of his rebuttal testimony, Mr. Dunn states that "VELCO believes that the original proposal was adequate but that a change in configuration would improve the design." Do you agree with this statement?

A. Not entirely. Our belief remains that VELCO's original proposal was not appropriate (for the reasons stated in the direct testimony of Mr. Smith at page 31, lines 1 through line 22) and that the change in the configuration agreed to by VELCO is necessary to achieve good utility practice, be maintainable, and meet any special needs that may arise beyond the immediate design scenario of the NRP.

Q. Regarding the footprint required by the STATCOM at Granite, on page 14 at lines 24 and 25 of his rebuttal testimony, Mr. Dunn states that "VELCO believes that the StatCom will fit in the footprint as originally filed." Do you agree with this statement?

A. We do not agree, based on the experience with the VELCO Essex STATCOM project where minimizing the footprint was a major concern. We observe that the proposed footprint for 150 MVAR at Granite is no larger than that required for only 75 MVAR at the Essex installation. In particular, we note that the building required for the inverters and

cooling equipment proposed by VELCO for Granite is approximately 5000 square feet (for 150 MVAR) compared with the Essex building of approximately 5500 square feet (for 75 MVAR). Since we are not aware of any recent breakthroughs in size reduction, we continue to believe that VELCO's proposed layout is inadequate.

Further, VELCO's proposed design for a synchronous condenser configuration requires 110 feet of additional space to the southwest and that a SVC configuration requires 125 feet of additional space. Since we believe that VELCO's space allocation for the 150 MVAR STATCOM is inadequate, and that the option of using other technologies should be kept open, we believe that ultimately VELCO will need additional space.

Q. Regarding cost estimates for Granite, on page 15 lines 9 and 10 of his rebuttal testimony, Mr. Dunn states that "VELCO believes that its original cost estimates are reasonable." Do you agree with this statement?

A. No. We note that the VELCO estimate is $100/kVAR ($15M for 150 MVAR) while Mr. Smith's estimate, based on actual experience with the Essex STATCOM project, is $180/kVAR ($27M for 150 MVAR). We also note that ISO-NE and the Connecticut utilities recently estimated the cost of 900 MVAR of STATCOM devices at $250M ($278/kVAR) for the proposed southwest Connecticut project. While this may be a relatively high planning-grade estimate reflecting various unknowns, it is further evidence that VELCO's cost estimates are likely low. We believe that the cost of a Granite STATCOM should be revised to more closely reflect the recent experience at Essex.

Q. In Mr. Dunn's rebuttal testimony on Page 14 at lines 11 through 17, VELCO proposes the use of a 115 kV underground cable connection at Granite to accommodate the separate connection of the 75 MVAR STATCOMs (or other form of dynamic VAR support) as was recommended by the Department. VELCO estimates that this would add approximately $600,000 to the project cost. Do you agree with this proposal?

A. We believe that the use of 115 kV underground should be considered only as a last resort, due to cost and reliability concerns, and that together with the added footprint recommended above that VELCO explore alternate station designs to avoid the use of an

underground 115 kV connection. If an overhead alternative is not feasible, we recommend consideration be given to moving the STATCOM step-up transformer to a position near the 115 kV ring bus and using low voltage cable between the STATCOM equipment and the transformer.

Response to Board Concern

Q. On July 30, 2004, during examination in the rebuttal phase of this docket, Chairman Dworkin posed questions to Mr. Smith regarding a blackout in Manhattan that occurred several years ago (Transcript of 7-30-04 at pages 82-83.) At that time, Mr. Smith testified that "I am not familiar with that particular incident, to tell you the truth, so - - I don't know if it was truly a first contingency incident." Can you, at this time, more fully address the questions posed by Chairman Dworkin?

A. Yes. To investigate this matter further, Mr. Smith contacted Dr. Mayer Sasson of Con Edison, who serves with Mr. Smith on the executive committee of the New York State Reliability Council. The only recent incident that Dr. Sasson can recall involving significant loss of customer load, other than the blackout of August 14, 2003, was a local problem in the Washington Heights section of Manhattan. This event occurred in a period of extreme heat in early July 1999, and involved the failure of eight of fourteen 13 kV distribution feeders serving the area. The failures occurred sequentially over a two day period. Upon failure of the eighth cable, the Con Edison operator manually terminated service to the 69,000 customers in the area to avoid further damage to the remaining cables. Service was restored after 19 hours. These failures were on the distribution network, not on the transmission network.

Reclosure

Q. The prefiled rebuttal testimony of Torben Aabo states on page one, answer three, that "some utilities that operate hybrid transmission lines have a practice of allowing one reclosure." Does the prefiled surrebuttal testimony of Department witness Jay Williams, in response to Mr. Aabo's testimony, cause you to change your opinion regarding reclosure on a hybrid 115kV line?

A. Yes. In our prefiled supplemental direct testimony, at pages 9 and 10, we state that "[b]ecause of [the] restriction on automatic reclosing for cables, an event that would result in the loss of an overhead line for a few seconds would probably result in the loss of a cable section for several hours." However, we have recently learned from Mr. Williams, as discussed on pages 7 and 8 of his prefiled surrebuttal testimony, that reclosing on 115kV hybrid lines could be permitted if, at each of the transitions between underground and overhead sections, there were relays to ensure that the fault is not on an underground section, reliable communications equipment, power supplies, current transformers, potential transformers, and an enclosed building for this equipment, all located in a fenced-in area. As a result, we now believe that with careful engineering,[3] further expenditures, and the willingness to trade simple transition structures for more elaborate fenced-in areas containing a building and more equipment, reclosing could safely be performed for faults on the overhead sections of hybrid lines. If such reclosing could be performed, and a four-cable system were employed, this would resolve our concerns with the reliability of a 115kV hybrid line.

Q. Does this complete your prefiled surrebuttal testimony?

A. Yes.

[3]Included in the engineering considerations is the fact that the introduction of cable into a transmission system can cause resonances and transient phenomena that can stress other electrical components in the system and cause harmful effects to customer loads. A detailed analysis would be required to determine any mitigative measures that may be required to ensure reliable performance of the interconnected system.